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【Title of the Invention】 Illuminator

【Abstract】

【Object】

It is an object of the present invention to provide an illuminator having an ultraviolet ray absorbing function, made compact in size by combining an apparatus for illumination and an apparatus for the above-mentioned deodorization or disinfection.

【Structure】

An illuminator comprises a light emitting part 2 of a light source containing ultraviolet rays, a cover member 3 which covers part or all of the light emitting part 2 and which reflects light emitted from the light emitting part 2 or allows the light to pass through it, and a semiconductor material 4 that includes titanium oxide modified by palladium, platinum, or the like, the titanium oxide being made to be present on the inner surface of the cover member 3 and experiencing a photo-catalytic reaction by means of the light emitted from the light emitting part 2. The light emitted from the light emitting part 2 is absorbed into the semiconductor material 4 to experience a photo-catalytic reaction, which makes odorless and harmless offensive odor-emitting gases and harmful gases near this semiconductor material 4. Further, the semiconductor material 4 absorbs ultraviolet rays as the photo-catalytic reaction proceeds, and so a costless fluorescent lamp with a plenty of ultraviolet rays can be safely used.

【What is claimed is:】

【Claim 1】

An illuminator having a light emitting part and a cover member set to cover part or all of this light emitting part, the cover member reflecting light emitted from the light emitting part or allowing the light to pass therethrough, wherein a semiconductor material experiencing a photo-catalytic reaction through the absorption of the light emitted from said light emitting part is made to be present on the surface of said cover member.

【Claim 2】

The illuminator according to claim 1, wherein said semiconductor material is made to be present on the inner surface of said cover member.

【Claim 3】

The illuminator according to claim 1 or 2, said illuminator employing as said semiconductor material a semiconductor material modified by one or more species of palladium, platinum, nickel, rhodium, niobium, copper, tin, ruthenium oxide and nickel oxide.

【Claim 4】

The illuminator according to any one of claims 1 to 3, said illuminator using as said semiconductor material one of titanium oxide, iron oxide, tungsten oxide, zinc oxide and strontium titanate.

【Claim 5】

The illuminator according to any one of claims 1 to 4, said illuminator using a light source containing a plenty of ultraviolet rays as said light emitting part.

【Detailed Description of the Invention】

【0001】

【Field of Industrial Application】

The present invention relates to an illuminator with secondary functions such as deodorization and disinfection of the surroundings and ultraviolet ray elimination in addition to an illumination function.

[0002]

[Prior Art]

Illuminators are generally only directed to the illumination of spaces such as interiors, bathrooms, telephone boxes, tunnels and platforms of subway stations. These illuminators are placed in sites such as ceilings of the above-mentioned closed spaces where daily activities are not hindered.

[0003]

However, in closed spaces such as the above-mentioned interior and telephone boxes, when foul-smelling gases or harmful gases are generated, these gases may cause troubles because these gases are confined within the space due to the above-mentioned space being closed. In this case, an apparatus for deodorization and disinfection must specially be installed when the confined gas cannot be efficiently discharged to the outside.

[0004]

In addition, fluorescent lamps, etc. used as the above-mentioned illuminator may contain ultraviolet rays in the light emitted from them. These ultraviolet rays are particularly contained in abundance in emitted light of a costless fluorescent lamp and are harmful to a human body. For this reason, fluorescent lamps, etc. have been improved so as to contain ultraviolet rays in their emitted light as few as possible.

[0005]

[Problem to be Solved by the Invention]

However, the above-mentioned illuminator and the above-mentioned apparatuses for deodorization or disinfection are independent and separate apparatuses and are individually provided.

[0006]

Moreover, a fluorescent lamp, etc. that has been improved not to contain ultraviolet rays in their emitted light inevitably requires increased costs and becomes expensive.

[0007]

The present invention has been made taking into account the above-mentioned problems, and an object of the present invention is to provide an illuminator made compact in size by combining an apparatus for illumination and the above-mentioned apparatus for deodorization or disinfection, the illuminator having an ultraviolet ray absorbing function while giving no troubles to the environment.

[0008]

[Means for Solving the Problem]

To solve the above-mentioned problems, the illuminator of the present invention is characterized in that it has a light emitting part and a cover member set to cover part or all of this light emitting part, the cover member reflecting light emitted from the light emitting part or allowing the light to pass therethrough, wherein a semiconductor material experiencing a photo-catalytic reaction through the absorption of the light emitted from the above-mentioned light emitting part is made to be present on the surface of the above-mentioned cover member.

[0009]

The above-mentioned semiconductor material is particularly desirably made to be present on the inner surface of the cover member. In addition, the semiconductor material for use desirably includes a semiconductor material modified by one or more species of palladium, platinum, nickel, rhodium, niobium, copper, tin, ruthenium oxide and nickel oxide. It is desirable to use titanium oxide, iron oxide, tungsten oxide, zinc oxide or strontium titanate as the above-mentioned semiconductor material. Further, a light source containing ultraviolet rays in abundance is desirably used as the above-mentioned light emitting part.

[0010]

[Functions]

In the above-mentioned configuration, the light emitted from the light emitting part normally acts as illumination light as well as being absorbed in the semiconductor material to

experience a photo-catalytic reaction, thereby making odorless and harmless foul-smelling gases and harmful gases near the semiconductor material. At the same time, the ultraviolet rays are absorbed in the semiconductor material, and so the emission of the harmful ultraviolet rays to the outside can be prevented.

【0011】

In this case, making the semiconductor material to be present on the inner surface of the cover member allows the light emitting part to directly irradiate the semiconductor material, thus to efficiently cause a photo-catalytic reaction. Use of titanium oxide, etc. modified by palladium, etc. as a semiconductor material can more efficiently conduct deodorization and disinfection and also cut harmful ultraviolet rays. Further, the use of a light source containing a plenty of ultraviolet rays as a light emitting part can increase the photo-catalytic reaction rate.

【0012】

【Embodiments】

Referring to drawings, the embodiments of the present invention will be set forth in detail hereinafter.

【0013】

An illuminator 1 of the present embodiment as shown in FIG. 1 is placed in a site that does not hinder daily activities, including a ceiling of a closed space such as an interior, a bathroom, a telephone box, a tunnel or the platform of a subway station. More specifically, the illuminator comprises a light emitting part 2, a cover member 3 which is disposed to cover the light emitting part 2 and which allows the light emitted from the light emitting part 2 to pass through it, and a semiconductor material 4 that is placed on the inner surface of the cover member 3 and experiences a photo-catalytic reaction by means of the light emitted from the light emitting part 2.

【0014】

For the light emitting part 2 is used a light source containing a plenty of ultraviolet rays in the emitted light, particularly a fluorescent lamp. This fluorescent lamp (particularly costless fluorescent lamp, for example, a white fluorescent lamp (Toshiba FL-4W)) contains an

abundance of ultraviolet rays of 400 nm or shorter, which contribute to a photo-catalytic reaction. In particular, an ultraviolet ray of 365 nm is contained in abundance. In addition, a BL lamp (for example, BLB fluorescent lamp (Sankyo Denki Corp. FL4BLB)) contains an abundance of ultraviolet rays with a central wavelength of 350 nm. Ultraviolet rays of these wavelengths are suitable for photo-catalytic reactions. Additionally, rays of the BL lamp rarely contain visible light, and so a normal fluorescent lamp is used in combination. Furthermore, the ultraviolet rays of 300 nm or shorter are very harmful to humans, while the near ultraviolet rays of 300 to 400 nm, emitted from the light emitting part 2 of the present embodiment, are little dangerous to the human body and further the semiconductor material 4 to be described later acts as an ultraviolet filter absorbing ultraviolet rays, and therefore the ultraviolet rays emitted from the light emitting part 2 have no effects on the human body.

【0015】

The cover member 3 is disposed so as to form a space including this light emitting part 2 by surrounding the light emitting part 2. This cover member 3 is composed of a material through which visible light can pass. Further, the cover member 3 has an inlet 3A of a gas at the lower part thereof and an outlet 3B of a gas at the upper part thereof, wherein the air warmed and expanded by the light emitting part 2 within the cover member 3 becomes light and rises to the outlet 3B at the upper part and then flows to the outside, and simultaneously air outside of the cover member 3 flows from the inlet 3A into the inside of the cover member 3. Outside of this inlet 3A, a shielding plate 3C is placed so that the ultraviolet rays from the light emitting part 2 are not directly emitted to the outside.

【0016】

On the inner surface of the cover member 3 is placed the semiconductor material 4. The semiconductor material 4 is made using titanium oxide, iron oxide, tungsten oxide, zinc oxide, strontium titanate, etc. Metals or metal oxides modifying this semiconductor material 4 include palladium, platinum, nickel, rhodium, niobium, copper, tin, ruthenium oxide and nickel oxide. Of these, one or more species are used to modify the semiconductor material 4. Irradiation of this semiconductor material 4 with light emitted from the light emitting part 2 exhibits a photo-

catalytic reaction, which photochemically decomposes and removes a variety of foul-smelling substances and harmful substances at room temperature. At the same time, during the photo-catalytic reaction, the semiconductor material 4 absorbs the ultraviolet rays emitted from the light emitting part 2.

【0017】

Now, means for forming a layer of the above-mentioned semiconductor material 4 includes the following.

【0018】

(1) Semiconductor thin film

A semiconductor thin film is formed on a substrate by means of the spin coating method, the dip coating method, the sol gel method, the sputtering method, etc.

【0019】

(2) Semiconductor powder

Powder-like semiconductor particles are immobilized on a substrate using some means. In this case, caution must be taken not to allow the fine particle surface to be covered with a non-active material (for example, adhesive). If covered, a photo-catalytic reaction does not occur.

【0020】

Of the two means above, although the method using (2) semiconductor powder is easier to give a semiconductor of a high reaction activity, immobilization of the semiconductor powder is more difficult. For this reason, (1) semiconductor thin film or the hybrid system of (1) semiconductor thin film and (2) semiconductor powder may be used; that is, fine particles are suspended in a titanium oxide sol solution and the resulting solution is applied and immobilized on a substrate by means of the spin coating method, the dip coating method, etc.

【0021】

Next, deodorization and disinfection by this photo-catalytic reaction and the function of ultraviolet ray cutting will be explained. Irradiation of the semiconductor material 4 with the light emitted from the light emitting part 2 induces the absorption of the light energy to activate electrons of the valance electron band by excitation, which come to possess strong oxidation and

reduction energy. In this state, the contact of the above-mentioned foul-smelling substances or harmful substances with the surface of the semiconductor material 4 reforms these substances to odorless, harmless gases by strong oxidation and reduction power of this semiconductor material 4. The ultraviolet rays reaching the semiconductor material 4 are absorbed by this semiconductor material 4 and are not emitted to the outside. In other words, the semiconductor material 4 acts as an ultraviolet ray filter, which absorbs ultraviolet rays. (For details of photo-catalytic reactions, etc., see Japanese Patent Publication No. 2-9850; Journal of JSES Vol. 15, No. 1, P30-33, 1989; monthly "Kagaku Kogyo" Vol. 39, No. 5, May issue, P47 (407), P48 (408), 1988.) During this time, the air within the cover member 3 is warmed and rises to the outlet 3B and then is flowed out. At the same time, new air from the outside is flowed into the cover member 3 through the inlet 3A. As a result, foul-smelling, harmful gases together with air are flowed into the cover member 3 to be reformed to odorless, harmless gases by the photo-catalytic reaction and then are flowed to the outside. Thus, this function is repeated step by step to make the whole space of the interior, etc. fill with odorless, harmless gas.

【0022】

This function continues while the illuminator 1 is on. Namely, as long as a user is in the space, the illuminator 1 is lit and the above-mentioned deodorization and disinfection are being conducted during lighting.

【0023】

The above-mentioned function can efficiently come to deodorize and disinfect foul-smelling, harmful gases of the whole space and also efficiently cut ultraviolet rays harmful to the human body.

【0024】

In addition, the photo-catalytic reaction does not have thermal deterioration or activity degradation due to poisoning elements as compared with the oxidation-catalytic reaction, etc., thus can facilitate the deodorization and disinfection functions and greatly extend the life for the ultraviolet ray filter.

【0025】

The illuminator 1, having a simple configuration of placing the cover member 3 on the light emitting part 2, can make the whole compact, can be utilized for confined space such as a telephone box, and can also be manufactured costlessly.

【0026】

Moreover, use of the light emitting part 2 of a fluorescent lamp, or the like that is costless and readily emits ultraviolet rays, also allows the semiconductor material 4 to absorb ultraviolet rays without leakage to the outside, thus can provide the costless and safety illuminator 1.

【0027】

Now, a second embodiment will be described.

【0028】

In an illuminator of the present embodiment, part of a cover that covers the light emitting part 2 is a reflecting plate. Reference numeral 7 in FIG. 2 indicates a cover member that covers the light emitting part 2, the upper part of which is a reflecting plate 8. The lower surface of the cover member 7 is composed of a transmittable plate 9, a member that can transmit light. These reflecting plate 8 and transmittable plate 9 cover the light emitting part 2. Further, a semiconductor material 10 similar to the above-mentioned semiconductor material is placed on the whole inner surface of these reflecting plate 8 and transmittable plate 9. An inlet 7A is disposed on the lower side of the cover member 7 and an outlet 7B is placed on the upper side thereof. A shielding plate 7C is placed in the outside of the inlet 7A such that the ultraviolet rays emitted from the light emitting part 2 are not directly emitted to the outside.

【0029】

In such a way, as a normal illumination function, the front of the reflecting plate 8 can primarily be irradiated with the direct light emitted from the light emitting part 2 and the reflected light reflected from the reflecting plate 8. In addition to this, a function as in the above-mentioned first embodiment can deodorize and disinfect foul-smelling gases and harmful gases in space such as an interior and also the semiconductor material 10 placed in the reflecting

plate 8 and the transmittable plate 9 absorbs the ultraviolet rays emitted from the light emitting part 2 as an ultraviolet ray filter.

[0030]

Further, the semiconductor material 10 is also placed on the inner surface of the reflecting plate, and so the inner surface of this reflecting plate 8 is cleaned by means of a photo-catalytic reaction, thereby always allowing the reflecting plate 8 to be kept in a good condition.

[0031]

In addition, in the above-mentioned two embodiments, the light emitting part 2 has been configured so as to completely cover the cover members 3 and 7; however, as illustrated in FIG. 3, the cover member 11 may be placed so as to cover only the part below the light emitting part 2 and open the part above the light emitting part 2. The illuminator may be fixed using a chain 12, or the like, together with the light emitting part 2. In this case, the part above the light emitting part 2 is open, and so the convection of air is enhanced even as compared with the above-mentioned two embodiments, resulting in improvement in efficiencies of deodorization and disinfection functions.

[0032]

Additionally, an air flowing plate 12 may be placed, as shown in FIG. 4, on a side wall 11A of the cover member 11. This air flowing plate 12 is made by removing part of the side wall 11A and setting long, slender plates in many layers, and thus can further improve the convection of the air in the cover member 11.

[0033]

Now, an experimental example (A) for deodorization effects will be demonstrated.

[0034]

An experimental apparatus as shown in FIG. 5 was used. Reference numeral 15 in the figure indicates a reaction bath that encloses odors. A light emitting part 16 was placed in this reaction bath 15, and a cover member 17, with a semiconductor material having been placed on the inner surface thereof, was disposed so as to cover the sides and the lower part of this light

emitting part 16. Further, a fan 18 was placed on the floor of the reaction bath 15 in order to improve the convection of the gas inside during light irradiation.

[0035]

The following four kinds of light sources were employed as the light emitting part 16.

[0036]

(1)	National Palook (EX-N)	10 W
(2)	National Daylight Color (D)	10 W
(3)	Black Light (BL)	10 W
(4)	Low pressure mercury-vapor lamp	10 W

A combination of any three of these was used for the light emitting part 16. A 10-liter container was used as the reaction bath 15.

[0037]

In addition, the materials below were used as the cover member 17.

[0038]

(1) Quartz glass

(2) Quartz glass coated with a TiO_2 film, wherein as the TiO_2 film was used a material sintered at 400°C after a TiO_2 sol offered by Taki Chemical Co., Ltd. was applied by spin coating.

[0039]

As an odor component was used acetaldehyde with an initial concentration of about 10 ppm. A gas chromatograph was used for quantitative and qualitative analyses.

[0040]

The experiment using the above-mentioned instruments gave the results as shown in the graph of FIG. 6. These curves were drawn using the results when the quartz glass coated with the TiO_2 film was employed as the cover member 17: the property line 21 is for no light irradiation, the property line 22 is for the case where three Daylight Colors were used as the light emitting part 16, the property line 23 is for the case where a combination of one Black Light and two Palooks was used as the light emitting part 16, and the property line 24 is for the case where

a combination of one low pressure mercury lamp and two Palooks was used as the light emitting part 16.

[0041]

These results have shown that a combination of one low pressure mercury lamp and two Palooks can most efficiently deodorize the odor as the light emitting part 16 as indicated by the property line 24. Additionally, the reason why the amount of acetaldehyde is decreased as shown by the property line 21 for no light irradiation is that acetaldehyde is adsorbed on the inner wall surface of the reaction bath 15.

[0042]

Also, when quartz glass uncoated with a TiO_2 film was used, the property line was in agreement within the experimental error with the property line 21 for no light irradiation in the graph of FIG. 6. In this case, the reason is that, as discussed previously, acetaldehyde is adsorbed on the inner wall surface of the reaction bath 15. The property line when three Palooks only were used was in agreement with the property line 21 for no light irradiation as well.

[0043]

Additionally, acetaldehyde is a representative odor component, and thus was used as an odor component in the above-mentioned experiment. Many studies on TiO_2 photo-catalysts have shown that if TiO_2 decomposes acetaldehyde, it also decomposes almost all other odor components (thiols, ammonia, mercaptans, etc.). Now, an experimental example (B) for deodorization effects will be set forth.

[0044]

In this experiment, as the TiO_2 semiconductor layer of the cover member 17 was used the semiconductor material 4 sintered at 400°C after 10 mg/10 mL of titanium oxide powder (P-25) offered by Nippon Aerogel Co., Ltd. was added to a TiO_2 sol offered by Taki Chemical Co., Ltd. and the resulting mixture was subjected to spin coating. A combination of one Black Light and two Palooks was used as the light emitting part 16. Except these, the experiment was carried out as in the above-mentioned experimental example (A).

[0045]

In this experiment, the residual percentage of acetaldehyde by means of light irradiation for about 10 minutes was about 30%. In other words, the deodorization ability was increased by about 1.5 times as compared with the case in the cover member 17 of quartz glass coated with a TiO_2 film for the experimental example (A).

[0046]

Now, an experimental example (C) for ultraviolet ray absorption ability of a TiO_2 film will be demonstrated.

[0047]

The following four light sources were used as the light emitting part 16.

[0048]

(1) Sun light

(2) 6 W-UV lamp

(3) 2 W-mercury vapor lamp

(4) 15 W-daylight color fluorescent lamp

The following two materials were used as ultraviolet ray absorption materials.

[0049]

(1) Quartz glass

(2) Alkaline glass coated with a TiO_2 film, for which the preparation method of the TiO_2 film was similar to the case in the experimental example (A). The sintering temperature only was altered.

[0050]

Absorption spectra were measured by ultraviolet/visible spectroscopy. Intensities of ultraviolet rays were determined using a Topcon UVR-1 ultraviolet ray intensity meter.

[0051]

FIG. 7 shows the measurements of absorption spectra of TiO_2 films. The absorption end is at about 380 nm. The absorption of alkaline glass coated with the TiO_2 film is shifted by

about 50 nm to the long wavelength side as compared with an alkaline glass substrate uncoated with a TiO_2 film.

[0052]

The intensity of ultraviolet rays was measured, as indicated in FIG. 8, by putting a substrate (quartz glass, alkaline glass coated with TiO_2 film) 32 at a distance of 60 cm from the light source or the natural sun light outside of the window (for example, sunlight at 1:00 PM in a sunny day) 31 and setting the ultraviolet ray intensity meter 33 behind the material.

[0053]

These measurements are shown in FIG. 9 (a), (b) and (c). FIG. 9 (a) shows measurements without the substrate, FIG. 9 (b) shows measurements for the case of putting quartz glass, and FIG. 9 (c) shows measurements for the case of putting alkaline glass coated with a TiO_2 film. These results show that ultraviolet rays near 360 nm are also mostly cut for the alkaline glass coated with a TiO_2 film.

[0054]

[Effect of the Invention]

As discussed thus far, according to illuminators of the present invention, the following effects can be obtained.

[0055]

(1) A photo-catalytic reaction of a semiconductor material present on the surface of a cover member can efficiently deodorize and disinfect foul-smelling, harmful gases and also absorb the ultraviolet rays emitted from a light emitting part to prevent the emission of these ultraviolet rays to the outside.

[0056]

(2) The photo-catalytic reaction does not cause a decrease in activity due to thermal deterioration or to poisoning elements as compared with the oxidation-catalytic reaction, etc., thus can facilitate the deodorization and disinfection functions and greatly extend the life for the ultraviolet ray filter.

[0057]

(3) The illuminator, having a simple configuration of placing a cover member on a light emitting part, can make the whole compact in size, can be utilized for confined space such as a bathroom, and can also be manufactured costlessly.

[0058]

(4) Use of a fluorescent lamp that is costless and readily emits ultraviolet rays also allows the semiconductor material to absorb ultraviolet rays without leakage to the outside, thus can provide a costless and safety illuminator.

[0059]

(5) The semiconductor material is placed on the inner surface of the reflecting member, and so the inner surface of this reflecting member is cleaned by means of a photo-catalytic reaction, thereby always allowing the reflecting member to be kept in a good condition.

[Brief Explanation of the Drawings]

FIG. 1 shows a brief sectional view of an illuminator relating to a first embodiment of the present invention.

FIG. 2 shows a brief sectional view of an illuminator relating to a second embodiment of the present invention.

FIG. 3 a brief sectional view of a variation of the present invention.

FIG. 4 shows a partial sectional view of a variation for the side wall of the cover member of FIG. 3.

FIG. 5 shows a brief block diagram of an illuminator used in the experiment for deodorization effects.

FIG. 6 shows a graph of the experimental results for deodorization effects.

FIG. 7 shows a graph for absorption spectral measurements of TiO_2 films.

FIG. 8 shows a schematic illustration for the configuration of the apparatus used in measurement of ultraviolet ray intensities.

FIG. 9 shows a graph of measurements of ultraviolet ray intensities.

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BASIC ABSTRACT:

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The lighting fixture has a light emitting part and a cover member provided on part or the whole of the light emitting part and reflecting or transmitting light emitted from light emitting part. A semiconductor material absorbing light and exerting photocatalytic reaction is provided on the surface of the cover member. The light emitting pat uses a light source contg. a large amt. of ultraviolet.

Pref. the semiconductor material at least one of palladium, platinum, nickel, rhodium, niobium, copper, tin ruthenium oxide or a nickel oxide.

USE - In a room a toilet, a telephone booth, a tunnel, on a subway (underground) station.

ADVANTAGE - The photocatalytic reaction effectively deodorises or disinfects malodours or a poisonous gas and absorbs ultraviolet emitted from the light emitting part. The photocatalytic reaction has no heat deterioration or a decrease in activity due to poisoning, thus prolonging deodorisation and disinfection actions.

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